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**2.1 BIOLOGICAL METHOD****LONG QUESTIONS**

**Q.1** Describe the steps involved in biological method.

(Knowledge Based)

**Ans:** STEPS INVOLVED IN BIOLOGICAL METHOD

In solving a biological problem, biologist takes following steps:

- Recognition of a biological problem
- Observations
- Hypothesis formulation
- Deductions
- Experimentation
- Summarization of results
- Reporting the results

**Recognition of a Biological Problem:**

Biologists go for **adopting a biological method** when they **encounter** some biological problem.

**Biological Problem:**

“A question related to living organisms that is either asked by some one or comes in biologist’s mind by himself is called biological problem.”

**Observations:**

A biologist recalls his/her previous observations or makes new ones.

**Use of Senses:**

Observations are made with five senses of:

- Vision
- Hearing
- Smell
- Taste
- Touch

**Types of Observations:**

**Observations may be both qualitative and quantitative.** Quantitative observations are **considered** more accurate than **qualitative ones** because the former are invariable and **measurable and can be recorded in terms of numbers.**

**Formulation of Hypothesis:**

Observations do not become scientific observations until they are organized and related to a question. Biologist organizes his/her and others’ observations into data form and constructs a statement that may prove to be the answer of the biological problem under study.

**Definition:**

“A tentative explanation of the observations is called as hypothesis.”

OR

“A proposition that might be true is called hypothesis.”

**Example:**

- *Plasmodium* is the cause of malaria.

**Characteristics:**

A good hypothesis should have the following characteristics:

- **It should be a general statement.**
- **It should be a tentative idea.**
- **It should agree with available observations.**
- **It should be kept as simple as possible.**
- **It should be testable and potentially falsifiable. In other words, there should be a way to show that the hypothesis is false, a way to disprove the hypothesis.**

**Reasoning:**

A great deal of **careful and creative thinking** is necessary for the formulation of a hypothesis. **Biologists use reasoning to formulate a hypothesis.**

**Deductions:**

In the next step, **the biologist draws deductions from the hypothesis.**

**Definition:**

**“The logical consequences of a hypothesis are called deductions.”**

**Explanation:**

For **formulating a deduction**, a hypothesis is taken as true and expected results (**deductions**) are drawn from it.

Generally, in a **biological method**, if a particular hypothesis is true, then one should expect (deduction) a certain result. **It involves the use of “if-then” logic.**

**Example:**

- **“If *Plasmodium* is the cause of malaria then all persons ill with malaria should have *Plasmodium* in their blood”.**

**Experimentation:**

The most basic **step of a biological method** is experimentation. A **biologist** performs experiments to see **if hypotheses are true or not.**

**Testing of Hypothesis:**

The deductions which are drawn from **hypothesis are subjected to rigorous testing.** Through **experimentation**, a **biologist learns which hypothesis is correct.**

The **incorrect hypotheses are rejected and the one** which proves correct is accepted. An accepted hypothesis makes further **predictions that provide an important way to further test its validity.**

**Control in Experiment:**

In science when **doing the experiment**, it must be a **controlled experiment.** The scientist must contrast an experimental group” with a **“control group”.** **The two groups are treated exactly alike except for the one variable being tested.**

**Example:**

In an experiment to test the necessity of carbon dioxide for photosynthesis, one can contrast the control group (a plant with freely available carbon dioxide) with an experimental group (a plant with no carbon dioxide available). The necessity of carbon dioxide will be proved when photosynthesis occurs in the control group and does not occur in the experimental group.

**Summarization of Results:**

**The biologist gathers actual quantitative data from experiments.**

**Statistical Analysis:**

Data for each of the groups are then averaged and compared statistically. To draw conclusions, a biologist also uses statistical analysis.

**Reporting the Results:**

Biologists publish their findings in scientific journals and books, discuss in talks at international and international meetings and present in seminars at colleges and universities.

**Importance:**

Publishing of results is an essential part of the scientific method. It allows other people to verify the results or apply the knowledge to solve other problems.

**THEORY****Definition:**

“The hypothesis that stands the test of time (often tested and never rejected), is called a theory.”

**Support of Theory:**

- A theory is supported by a great deal of evidence.
- A productive theory keeps on suggesting new hypotheses and so testing goes on.

Many biologists take it as a challenge and exert greater efforts to disprove the theory.

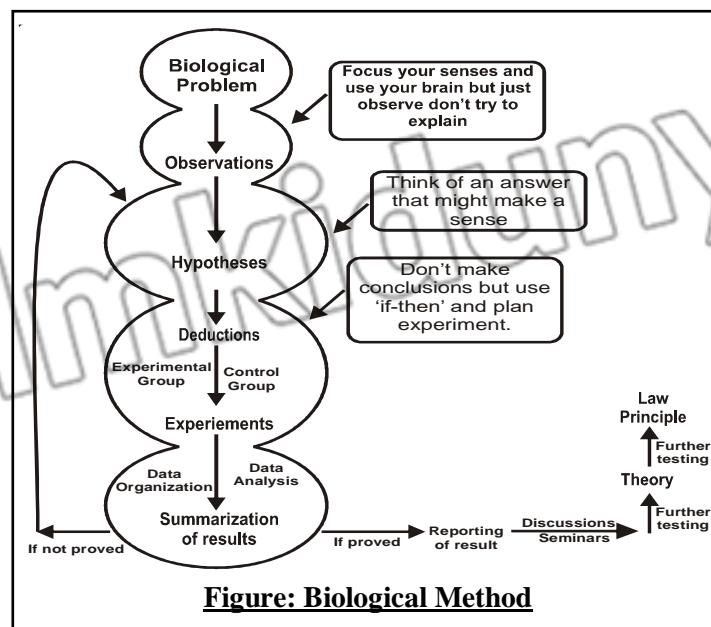
**LAW OR PRINCIPLE****Definition:**

If a theory survives any doubtful approach and continues to be supported by experimental evidence, it becomes a law or principle.

- A scientific law is a uniform or constant fact of nature.
- It is an irrefutable theory.

**Examples:**

- Hardy-Weinberg Law
- Mendel's Laws of Inheritance



**Q.2 Describe the steps involved in biological method taking malaria as an example.**

(Knowledge Based)(Ex Q. No. 2)

**Ans: MALARIA AS AN EXAMPLE OF BIOLOGICAL METHOD**

**Introduction:**

**Malaria has killed more people than any other disease.** The account of malaria is an example of a biological problem and of how such problems are solved.

**Common Disease:**

**Malaria is a common disease in many countries including Pakistan.**

**Steps:**

Steps taken to solve this problem were as follows:

**i. Recognition of Problem:**

In ancient times (more than **2000 years ago**), physicians were familiar with malaria. They described it as a disease of chills and fevers with recurring attacks.

**ii. Observations About Malaria:**

**In the last part of 19<sup>th</sup> century many different causes of malaria were being suggested. By that time there were four major observations about malaria.**

- **Malaria and marshy areas have some relation.**
- **Quinine is an effective drug for treating malaria.**
- **Drinking water from marshes does not cause malaria.**
- **'Plasmodium' is seen in the blood of malarial patients.**

**iii. Hypothesis Formulation:**

**A scientist uses whatever information and observation he has and makes one or more hypotheses. The hypothesis made in this case was:**

- **'Plasmodium is the cause of malaria'.**

**iv. Deductions:**

**A scientist does not know whether this hypothesis is true or not, but he accepts that it may be true and makes deductions. One of the deductions from the above hypothesis was:**

- **'If Plasmodium is the cause of malaria, then all persons ill with malaria should have Plasmodium in their blood'.**

**v. Experimentation:**

**The next step was to test deduction through experiments which were designed as follows:**

**Experimental Group:**

**Blood of 100 malarial patients was examined under the microscope.**

**Control Group:**

**Blood of 100 healthy persons was examined under the microscope.**

**Results:**

- **The experimental group results showed that almost all malarial patients had Plasmodium in their blood.**
- **In control group 7 out of 100 healthy persons also had Plasmodium in their blood. Plasmodium in the blood of healthy individuals was in its incubation period i.e. the period between the entry of parasite in the host and appearance of symptoms.**

**The results were quite convincing and proved that the hypothesis, 'Plasmodium is the cause of Malaria' was true.**

**The next biological problem was to learn about 'How Plasmodium gets into the blood of a man?'**

**Observations:**

Biologists were having the following observations:

- **Malaria is associated with marshes.**
- **Drinking water of marshes does not cause malaria.**

From these observations, it can be concluded that *Plasmodium* was not in the marsh water. It must be carried by something that comes to marsh water.

**Observations of A.F.A. King:**

(LHR 2012)

In 1883, a physician, A.F.A. King, listed 20 observations:

Some of his important observations were:

- **People who slept outdoors were more likely to get malaria than those who slept indoors.**
- **People who slept under fine nets were less likely to get malaria than those who did not use such nets.**
- **Individuals who slept near a smoky fire usually did not get malaria.**

**Hypothesis:**

On the basis of his observations, King suggested a hypothesis:

- **‘Mosquitoes transmit *Plasmodium* and so are involved in the spread of malaria’.**

**Deductions:**

Following deductions were made considering the hypothesis as true.

- **‘If mosquitoes are involved in the spread of malaria, then *Plasmodium* should be present in mosquitoes.’**
- **‘If mosquitoes are involved in the spread of malaria, then a mosquito can get *Plasmodium* by biting a malarial patient.’**

**Experiments of Ronald Ross:**

In order to test the above deductions, Ronald Ross, a British army physician working in India, in 1880’s, performed important experiments.

**Experiment 1:**

- **He allowed a female *Anopheles* mosquito to bite a malarial patient.**
- **He killed the mosquito some days later.**
- **On examining the mosquito, *Plasmodium* was found multiplying in mosquito’s stomach.**

**Experiment 2:**

The next logical experiment was to allow an infected mosquito (having *Plasmodium*) bite a healthy person.

If the hypothesis was true, the healthy person would have got malaria. But scientists avoid using human beings for experiments when results can be so serious. Ross used sparrows and redesigned his experiments.

He allowed a female *Culex* mosquito to bite the sparrows suffering from malaria.

- **Some of the mosquitoes were killed and studied at various times.**
- **Ross found that *Plasmodium* multiplied in the wall of mosquito’s stomach and then moved into the mosquito’s salivary glands.**
- **He kept some of the mosquitoes alive and allowed them to bite healthy sparrows.**

**Results:**

Ross found that saliva of the infected mosquitoes contained *Plasmodia* and these *Plasmodia* entered sparrow's blood. When he examined the blood of these previously healthy sparrows, he found many *Plasmodia* in it.

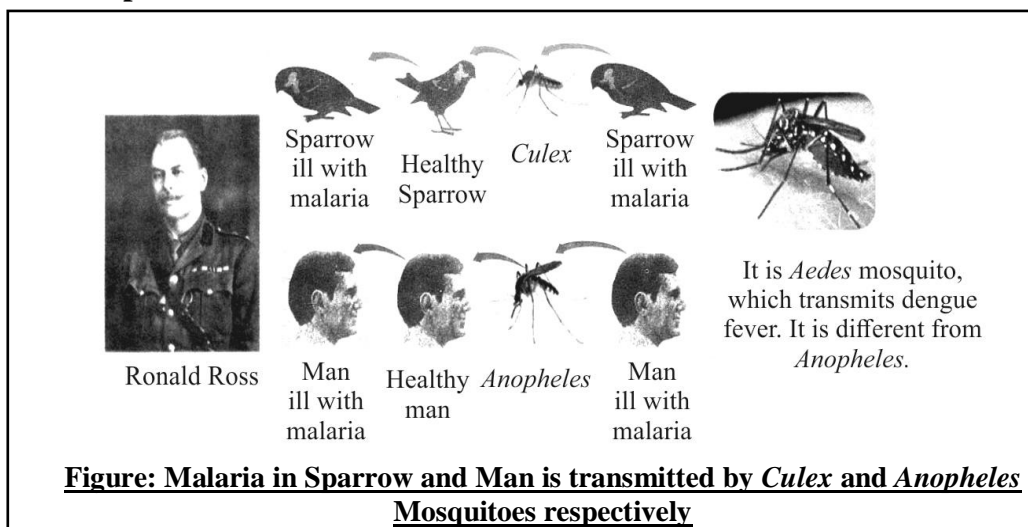
**Experimentation on Man:**

In the end, the hypothesis was tested by direct experimentation on human beings. In 1898, Italian biologists took these steps for confirmation:

- They allowed an *Anopheles* mosquito to bite a malarial patient.
- The mosquito was kept for a few days.
- Then it was allowed to bite a healthy man.

**Results:**

- The person later became ill with malaria.
- In this way it was confirmed that mosquitoes transmit *Plasmodium* and spread malaria.

**SHORT QUESTIONS (Topic 2.1)**

**Q.1** Do you think that “Man has always been a biologist”? If so why? (K.B)

**Ans:** A man has always been a biologist. He had to be a biologist in order to live. Early in history, he was hunter of animals and a gatherer of fruit, seeds, roots etc. the more he knew about animals and their habitat, the more successful hunter he was. The more he knew about plants, the better he distinguished between edible and no-edible plants.

**Q.2** Give importance of biological method (K.B)

(GRW-G1-2014)

**Ans: Importance of biological method:**

Biological method has contributed to:

- 1) Advancement in medicine
- 2) Ecology
- 3) Technology

Ensure the quality of data for public use

**Q.3 Define biological method. (K.B)** (GRW 2013, DGK 2015, BWP 2015)

**Ans:** **BIOLOGICAL METHOD**

**Definition:**

“The scientific method in which biological problems are solved is termed as biological method.”

**Q.4 How biological method has played an important part in scientific research? (A.B)**

**Ans:** **BIOLOGICAL METHOD AND SCIENTIFIC RESEARCH**

The biological method has played an instrumental role in scientific research for almost 500 years.

- From Galileo’s experiment back in the 1590’s to current research, the biological method has contributed to advancements in medicine, ecology, technology, etc.
- The biological method ensures the quality of data for public use.

**Q.5 Write steps of biological method in a sequence. (K.B)**

**Ans:** Page no 34.

**Q.6 Define biological problem. (K.B)**

(FSD 2014, SGD 2014)

**Ans:** Page no 34.

**Q.7 What do you know about observation? (K.B)**

**Observation:**

**Ans:** Observation is the previous knowledge about any aspect of life or can be made with five senses i.e.

- Vision
- Hearing
- Smell
- Taste
- Touch.

**Example:** Different observations about malaria are:

- Disease of chills and fever.
- Association of malaria with marshes.

**Q.8 What is the difference between qualitative and quantitative observations? (A.B)**

(GRW 2012, LHR 2013, SWL 2014, MTN 2015, BWP 2015)

**Ans:** **DIFFERENTIATION**

The differences between qualitative and quantitative observations are as follow:

Qualitative Observations	Quantitative Observations
<b>Accuracy</b>	
Qualitative observations are considered less accurate.	Quantitative observations are considered more accurate.
<b>Variability</b>	
These observations are variable and less measurable.	These observations are invariable and measurable.
<b>Record</b>	
These cannot be recorded in terms of numbers.	These can be recorded in terms of numbers.



Examples	
<ul style="list-style-type: none"> <li>• The freezing point of water is colder than its boiling point.</li> <li>• A liter of water is heavier than a liter of ethanol.</li> </ul>	<ul style="list-style-type: none"> <li>• The freezing point of water is 0°C and the boiling point is 100°C.</li> <li>• A liter of water weighs 1000 grams and a liter of ethanol weighs 789 grams.</li> </ul>

**Q.9 Why quantitative observations are better in biological method? (A.B)**

(DGK 2014, GRW 2014, RWP 2014, LHR 2015)

**Ans:** Page no 34.

**Q.10 How did Darwin formulate the theory of evolution? (K.B)**

**Ans:** **FORMULATION OF DARWIN'S THEORY OF EVOLUTION**

Darwin not only observed and took notes during his voyage, but he also read the works of other naturalists to form his theory of evolution.

**Q.11 Define hypothesis. (K.B)**

(BWP 2015)

**Ans:** Page no 34.

**Q.12 How hypothesis is framed? (K.B)**

**Ans:** Page no 34.

**Q.13 What are the characteristics of a good hypothesis? (K.B)** (LHR 2012, 2015, 2016, RWP 2015)

**Ans:** Page no 35.

**Q.14 Define deductions. How deductions are formed? (A.B)** (LHR 2012, MTN 2015, SGD 2015)

**Ans:** Page no 35.

**Q.15 Develop a deduction from the following hypothesis. (U.B)**

“All plant cells have a nucleus.”

**Ans:** Page no 35.

**Q.16 Why does a biologist go for experimentation during solving a biological problem? (U.B)**

**Ans:** Page no 35.

**Q.17 How would you check the necessity of carbon dioxide for photosynthesis? Necessity of CO<sub>2</sub>: (A.B)** (LHR-GII-14)

**Ans:** To check the necessity of CO<sub>2</sub> for photosynthesis, we will make two groups.

- Experimental group:
- Control group

**Experimental group:**

A group of plants which will not be provided with CO<sub>2</sub>.

**Result:** No photosynthesis will take place.

**Control group:** A group of plants which will be provided with CO<sub>2</sub>

**Result:** Photosynthesis will take place which can be checked by Iodine test.

**Q.18 What is control in an experiment (U.B)** (LHR 2013, 2014, DGK 2014, FSD 2015, RWP 2015)

**Ans:** Page no 35.

**Q.19 What are different ways of reporting results of biological method? (U.B)** (SWL 2015)

**Ans:** Page no 36.

**Q.20 How would you summarize the result of an experiment? (A.B)**

**Ans:**

- **Result of an experiment:**

Biologist gathers actual, quantitative data from experiments which are a uniform or constant fact of nature.

- **Application of statistics:**

Data of each of the group are then averaged and compared statistically.

**Q.21 How would you report the result of an experiment. (A.B)**

**Reporting the result:**

**Ans:** Publishing of results is an essential part of scientific method. Biologists publish their findings in:

- Scientific journals and books
  - In talks at national and international level
- In seminars at colleges and universities

**Q.22 How did physicians describe malaria in early days? (K.B)**

**Ans:** DESCRIPTION OF MALARIA IN EARLY DAYS

The physicians described malaria in early days as:

- A disease of chills and fevers with recurring attacks.
- The disease more common among people living in low, marshy areas.

**Q.23 What was the possible cause of malaria in early days? (K.B)**

**Ans:** POSSIBLE CAUSE OF MALARIA IN EARLY DAYS

It was thought in early days that stagnant water of marshes poisoned the air and as a result of breathing in this 'Bad Air', people got malaria.

**Q.24 What does the word malaria mean? (K.B)**

(LHR 2014)

**Ans:** MEANING OF MALARIA

The word malaria has been derived from two Italian words:

- 'Mala' means 'bad'
- 'Aria' means 'air'

**Q.25 What was the treatment of malaria in early days? (A.B)**

**Ans:** TREATMENT OF MALARIA IN EARLY DAYS

In the 17<sup>th</sup> century, when the New World (America) was discovered, many plants from America were sent back to Europe to be used as medicines. The bark of a tree known as 'quina-quina' was very suitable for curing fevers. It was so beneficial that it soon became impossible to carry enough bark to Europe. Some dishonest merchants began to substitute the bark of another tree. The 'cinchona' which closely resembled quina-quina.

This dishonesty proved much valuable for mankind. The cinchona bark was found to be excellent for treating malaria. The cinchona bark contains quinine which is effective in treating the disease. Quinine was the only effective remedy for malaria from 17<sup>th</sup>-20<sup>th</sup> century.

**Q.26 Describe the contributions of Laveran in discovery of Plasmodium. (K.B) (RWP 2014)**

**Ans:** CONTRIBUTION OF LAVERAN

In 1878, a French army physician Laveran began to search for the cause of malaria.

**Experiments:**

He took a small amount of blood from a malarial patient and examined it under a microscope. He noticed some tiny living creatures. His discovery was not believed by other scientists.

**Confirmation:**

- Two years later, another physician saw the same creatures in the blood of another malarial patient.
- Three years later after the second discovery, the same creatures were observed for the third time.

**Naming of Organism:**

The organism was named '*Plasmodium*'

**Q.27** What were observations for malaria until 19<sup>th</sup> century? (K.B) (FSD 2015)

**Ans:** Page no 37.

**Q.28** What is incubation period? (K.B) (SWL 2015)

**Ans:** Page no 37.

**Q.29** Design a deduction from following hypothesis. (U.B)

“*Plasmodium* is cause of malaria”

**Ans:** Page no 37.

**Q.30** Write down observations of A.F.A. King about malaria. (K.B) (LHR 2014, MTN 2015)

**Ans:** Page no 38.

**Q.31** What is required for the maturation of eggs of female mosquito? (K.B)

**Ans:** Page no 38.

**Q.32** Why Ronald Ross used sparrows in his experiment? (A.B) (GRW 2014)

**Ans:** Page no 38.

**Q.33** How did Ross prove that mosquitoes transmit *Plasmodium* and spread malaria? (A.B) (GRW 2012)

**Ans:** Page no 39.

**Q.34** Why does female mosquito inject small amount of saliva into the wound? (A.B)

**Ans:**

**INTECTION OF SALIVA**

When a female mosquito pierces the skin with her mouth parts, she injects a small amount of saliva into the wound before drawing blood. This saliva prevents the blood from clotting in its food canal.

**Q.35** Why do welts appear after mosquito bite? (A.B) (LHR 2013)

**Ans:**

**APPEARANCE OF WELTS AFTER MOSQUITO BITE**

The welts that appear after mosquito bite is not a reaction to the wound, but an allergic reaction to the saliva. In most cases, the itching sensation and swelling subside within several hours.

**Q.36** What is scientific law? Give two examples. (K.B) (LHR 2013, SWL 2014)

**Ans:**

**SCIENTIFIC LAW****Definition:**

“If a theory survives doubtful approach and continues to be supported by experimental evidence, it becomes a law or principle.”

- A scientific law is a uniform or constant fact of nature. It is an irrefutable theory.

**Examples:**

- Hardy-Weinberg Law
- Mendel's Laws of Inheritance

**Q.37** What is difference between theory and law? (K.B) (SWL 2014, DGK 2014, LHR 2015, 2016)

**Ans:**

**DIFFERENTIATION**

The differences between theory and law are as follow:

Theory	Law
<b>Definition</b>	
A hypothesis that stands the test of time (often tested and never rejected) is called theory.	A scientific law is a uniform, constant fact of nature. It is irrefutable theory.
<b>Challenge</b>	
A theory may be challenged.	A law cannot be challenged.

<b>Alteration</b>	
A theory can be altered in case of new evidence.	A law is already an established and definite entity. It cannot be altered.
<b>New Testing</b>	
A theory is always subjected to new testing	A law is not subjected to further testing.
<b>Examples</b>	
<ul style="list-style-type: none"> <li>• Darwin's Theory of Evolution</li> <li>• Cell Theory</li> </ul>	<ul style="list-style-type: none"> <li>• Hardy-Weinberg Law</li> <li>• Mendel's Laws of Inheritance</li> </ul>

### MULTIPLE CHOICE QUESTIONS (Topic 2.1)

1. **Scientists that use scientific method to make new theories: (K.B)**  
 (A) Biologist (B) Chemists  
 (C) Physicists (D) All of these
2. **The principles about operations of nature is determined by: (U.B)**  
 (A) Observations (B) Hypothesis  
 (C) Experiments (D) Deductions
3. **The scientific method in which biological problems are solved is called: (K.B) (SGD 2014)**  
 (A) Geological problem (B) Biological method  
 (C) Non-biological method (D) All of these
4. **Biological method has played an important part in scientific research for almost: (K.B)**  
 (A) 700 years (B) 500 years  
 (C) 600 years (D) 525 years
5. **The theory of evolution was developed by: (K.B)**  
 (A) Galileo (B) Ronald Ross  
 (C) Darwin (D) A.F.A King
6. **Biological method comprises of \_\_\_\_\_ steps. (K.B) (MTN 2015)**  
 (A) 5 (B) 6  
 (C) 7 (D) 8
7. **Galileo performed his experiments in: (K.B)**  
 (A) 1690's (B) 1790's  
 (C) 1590's (D) 1650's
8. **The problem related to living organisms: (K.B)**  
 (A) Chemical (B) Geological  
 (C) Biological (D) Physical
9. **Quantitative observations are considered: (K.B)**  
 (A) Less accurate (B) Invariable  
 (C) More accurate (D) Both B and C
10. **The freezing point of water: (A.B)**  
 (A) 10°C (B) 0°C  
 (C) 5°C (D) 15°C
11. **Weight of one kilogram of water: (A.B) (GRW 2014)**  
 (A) 900 grams (B) 1000 grams  
 (C) 800 grams (D) 700 grams

12. **Weight of one kilogram of ethanol: (A.B)**  
(A) 879 grams (B) 789 grams  
(C) 987 grams (D) 768 grams
13. **A proposition that might be true: (K.B)**  
(A) Deduction (B) Theory  
(C) Law (D) Hypothesis
14. **The tentative explanation of observation is called: (K.B)** (DGK 2014)  
(A) Hypothesis (B) Theory  
(C) Deductions (D) Result
15. **Which one of the following is not the characteristic of a good hypothesis? (K.B)** (LHR 2015)  
(A) Must be consistent with available data (B) Must be testable  
(C) Must be correct (D) Must have prediction
16. **Logical consequence drawn from hypothesis: (K.B)** (RWP 2014, 2015, SGD 2015, DGK 2015, GRW 2013)  
(A) Observation (B) Deduction  
(C) Experimentation (D) Result
17. **In biological method the next step of hypothesis is called: (K.B)** (LHR 2012)  
(A) Deduction (B) Observation  
(C) Result (D) Experiment
18. **“If I examine cells from a blade of grass, then each one will have a nucleus”. This statement is: (U.B)**  
(A) Theory (B) Hypothesis  
(C) Deduction (D) Law
19. \_\_\_\_\_ **is most basic step of biological method. (K.B)** (MTN 2014)  
(A) Observations (B) Hypothesis  
(C) Experimentation (D) Deductions
20. **Physicians were familiar with malaria \_\_\_\_\_ years ago. (K.B)**  
(A) 2000 (B) 2500  
(C) 1500 (D) 2100
21. **The word malaria has been derived from which language? (K.B)**  
(A) German (B) Italian  
(C) French (D) Greek
22. **The word “mala” means: (K.B)**  
(A) Air (B) Bad  
(C) Poor (D) Poison
23. **When was America discovered? (K.B)**  
(A) 16<sup>th</sup> century (B) 17<sup>th</sup> century  
(C) 18<sup>th</sup> century (D) 20<sup>th</sup> century
24. **Which disease has killed more people than any other disease? (K.B)**  
(A) Cancer (B) AIDS  
(C) Tuberculosis (D) Malaria
25. **Bark of quina-quina was used for treating: (A.B)**  
(A) Typhoid (B) Malaria  
(C) Tetanus (D) Fever

26. **The bark of which tree was very suitable for curing malaria?** (A.B) (SWL 2015, LHR 2015)  
 (A) *Cedrus* (B) *Cinchona*  
 (C) *Pinus* (D) *Cactus*
27. **Quinine is obtained from:** (A.B)  
 (A) *Cinchona* bark (B) Quina-quina bark  
 (C) Both A and B (D) None of these
28. **The bark of *Cinchona* contains a chemical:** (U.B) (SWL 2015, GRW 2012)  
 (A) Gum (B) Quinine  
 (C) Glue (D) Honey
29. **Quinine is an effective remedy for:** (A.B) (GRW 2013)  
 (A) Diabetes (B) Malaria  
 (C) Cholera (D) Diarrhoea
30. **Most effective remedy against malaria upto 20<sup>th</sup> century:** (A.B) (BRW 2014)  
 (A) Ranitidine (B) Quinine  
 (C) Amoxicillin (D) All of these
31. **French army physician who worked on malaria in 1878:** (K.B) (SGD 2015)  
 (A) Laveran (B) Ronald Ross  
 (C) A.F.A. King (D) Mendel
32. **Who started to know the reason of malaria?** (K.B) (GRW 2012)  
 (A) Haeckel (B) Laveran  
 (C) Ronald Ross (D) Mendel
33. **Laveran began to search for cause of malaria in:** (K.B)  
 (A) 1978 (B) 1870  
 (C) 1878 (D) 1880
34. **Who discovered *Plasmodium*?** (K.B)  
 (A) Laveran (B) A. F. A. King  
 (C) Ronald Ross (D) Darwin
35. ***Plasmodium* was discovered in:** (K.B)  
 (A) 1876 (B) 1878  
 (C) 1880 (D) 1882
36. **Malaria is caused by:** (K.B) (FSD 2015, DGK 2015, SWL 2014, LHR 2014)  
 (A) *Plasmodium* (B) *Entamoeba*  
 (C) *Paramecium* (D) *E. coli*
37. **“If *Plasmodium* is the cause of malaria, then all the persons ill with malaria should have *Plasmodium* in their blood”. This statement is:** (U.B) (LHR 2013)  
 (A) Hypothesis (B) Deduction  
 (C) Theory (D) Law
38. **Mark the incorrect observation about malaria.** (K.B)  
 (A) Malaria is associated with marshes.  
 (B) Quinine is an effective drug for treating malaria.  
 (C) Drinking water of marshes causes malaria.  
 (D) Individuals who slept near a smoky fire usually did not get malaria.
39. **In which year, A. F. A. King listed his twenty observations:** (K.B) (GRW 2014, LHR 2014, 2015)  
 (A) 1881 (B) 1882  
 (C) 1883 (D) 1884

40. How many observations were presented by A.F.A. King? (K.B) (GRW 2013)  
 (A) 14 (B) 18  
 (C) 20 (D) 22
41. Ronald Ross belonged to: (K.B)  
 (A) German (B) Great Britain  
 (C) Holland (D) America
42. Ronald Ross performed experiments in: (K.B) (BRW 2015)  
 (A) 1878 (B) 1880  
 (C) 1885 (D) 1888
43. "Mosquitoes transmit *Plasmodium* and are involved in spread of malaria." Who suggested this hypothesis? (U.B) (LHR 2012)  
 (A) Laveran (B) Aristotle  
 (C) Redi (D) A.F.A. King
44. Female mosquitoes used by Ross in his experiments: (A.B)  
 (A) *Anopheles* and *Aedes* (B) *Aedes* and *Culex*  
 (C) *Culex* and *Anopheles* (D) All of these
45. Female mosquitoes need the blood of \_\_\_\_\_ for the maturation of their eggs. (K.B) (MTN 2015)  
 (A) Mammals (B) Birds  
 (C) Both A and B (D) Reptiles
46. *Anopheles* mosquito causes: (K.B) (DGK 2014)  
 (A) Dengue (B) Malaria  
 (C) Typhoid (D) Flu
47. Malaria in sparrows is spread by: (A.B) (BRW 2015, GRW 2012, 2016, LHR 2012, 2016)  
 (A) Ordinary mosquito (B) *Culex* mosquito  
 (C) *Anopheles* mosquito (D) *Aedes* mosquito
48. *Plasmodium* is transferred by: (A.B)  
 (A) Fly (B) Virus  
 (C) Mosquito (D) Bacteria
49. Who is responsible for spread of malaria fever? (A.B) (SGD 2014, SWL 2014)  
 (A) Virus (B) *Plasmodium*  
 (C) *Amoeba* (D) *Paramecium*
50. Ross found *Plasmodium* multiplying in: (K.B) (GRW 2013)  
 (A) Salivary glands (B) Blood  
 (C) Stomach (D) Both A and C
51. Mosquito that transmits dengue fever: (K.B) (LHR 2016)  
 (A) *Culex* (B) *Anopheles*  
 (C) *Aedes* (D) Female *Anopheles* mosquito
52. In dengue fever, which cells are shortened? (A.B) (RWP 2014)  
 (A) Erythrocytes (B) Platelets  
 (C) Leucocytes (D) White blood cells
53. Blood clotting in food canal of mosquito is prevented by: (A.B)  
 (A) Lymph (B) Platelets  
 (C) Saliva (D) Tissue fluid

54. A hypothesis that is often tested and never rejected is called: (K.B) (GRW 2012, 2015)  
 (A) Law (B) Theory  
 (C) Principle (D) Deduction
55. The hypotheses that stand the test of time are called: (K.B) (FSD 2014, LHR 2012)  
 (A) Experiments (B) Deductions  
 (C) Theories (D) Observation
56. A theory is supported by a great deal of: (K.B)  
 (A) Evidence (B) Result  
 (C) Experiment (D) Observation
57. An irrefutable theory: (K.B)  
 (A) Deduction (B) Law  
 (C) Hypothesis (D) Observation

## 2.2 DATA ORGANIZATION AND DATA ANALYSIS

### LONG QUESTIONS

**Q.1** Write a note on data organization. (Knowledge Based)

**Ans:** DATA ORGANIZATION

**Definition:**

“The information such as names, dates or values made from observations and experimentation is called data.”

In order to formulate and then to test a hypothesis, scientists collect and organize data.

**Data Collection Methods:**

Prior to conducting an experiment, it is very important for a scientist to describe the data collection methods. It ensures the quality of the experiment.

**Formats:**

Data is organized into different formats like:

- Graphics
- Tables
- Flow charts
- Maps
- Diagrams

**Q.2** Write a note on data analysis. (Application Based)(Ex Q. No. 3)

**Ans:** DATA ANALYSIS

Data analysis is necessary to prove or disprove a hypothesis by experimentation.

**Statistical Methods:**

Data analysis is done through application of statistical methods, i.e. ratio and proportion.

**Ratio:**

When a relation between two numbers e.g. ‘a’ and ‘b’ is expressed in terms of quotient (a/b) it is called the ratio of one number to the other.

**Expression of a Ratio:**

A ratio is expressed by putting a division (÷) or colon ( : ) mark between two numbers.

**Example:**

- The ratio between 50 malarial patients and 150 normal persons is 1:3.



**Proportion:**

Proportion means to join two equal ratios by the sign of equality (=).

Proportion may be expressed as:

$$a:b :: c:d$$

**Example:**

$a : b = c : d$  is a proportion between the **two ratios**.

**Calculation of Fourth Value:**

When **three** values in a **proportion** are known, the fourth one (**X**) can be **calculated**.

**Example:**

- A biologist can calculate how many birds will get malaria when he allows infected mosquitoes to bite 100 healthy sparrows. In the previous experiment he noted that when he allowed mosquitoes to bite 20 sparrows, 14 out of them got malaria. Now he may apply the proportion rule:

1<sup>st</sup> Ratio:            14 : 20 (14 out of 20)

2<sup>nd</sup> Ratio:            X : 100 (How many out of 100)

Proportion:        14 : 20 :: X : 100

$$\frac{X}{100} = \frac{14}{20}$$

$$X \times 20 = 100 \times 14$$

$$X = \frac{100}{20} \times 14$$

$$X = 70$$

It means, 70 out of 100 sparrows would get malaria.

**Importance of Statistics:**

Statistics are thus a means of summarizing data through the calculation of a mean value. This step is very important as it transforms raw data into information, which can be used to summarize and report results.

**Q.3 Explain Mathematics as an integral part of scientific process. (A.B) (Ex Q. No. 4)**

**Ans:            MATHEMATICS AS AN INTEGRAL PART OF SCIENTIFIC PROCESS**

Biological method involves the use of Applied Mathematics to solve biological problems.

**Mathematical Applications:**

Major biological problems, in which knowledge of **Mathematics** is used include:

- **Gene finding**
- **Protein structure**
- **Protein-protein interactions**

**Bioinformatics:**

**Bioinformatics** refers to the computational and statistical techniques for the analysis of biological data.

**SHORT QUESTIONS (Topic 2.2)**

**Q.1 Define data. (K.B)**

**Ans:** Page no 48.

**Q.2 In which formats data is organized? (K.B)**

**Ans:** Page no 48.

**Q.3 Define ratio. (K.B)**

(MTN 2015)

**Ans:** Page no 48.

**Q.4** In what major biological problems is the knowledge of Mathematics used? (A.B)

Ans: Page no 49.

**Q.5** Define Bioinformatics. (K.B)

(SWL 2014, BWP 2014, LHR 2016)

Ans: Page no 49.

### MULTIPLE CHOICE QUESTIONS (Topic 2.2)

- The information such as names, dates or values made from observations and experimentation: (K.B)  
(A) Data (B) Theory (C) Law (D) Observation
- A relation between two numbers in terms of quotient is called: (A.B)  
(A) Proportion (B) Ratio (C) Both A and B (D) None of these
- Proportion is expressed by putting a sign: (K.B)  
(A) = (B) :: (C) Both A and B (D) :
- Summarizing data through the calculation of a mean value: (K.B)  
(A) Mathematics (B) Statistics (C) Physics (D) Economics
- Computational and statistical techniques for the analysis of biological data are studied in: (K.B)  
(A) Biomathematics (B) Biophysics (C) Bioinformatics (D) Biochemistry
- A mean of summarizing data through the calculation is: (A.B)  
(A) Statistics (B) physics (C) Biometry (D) Bioeconomics
- We can transform a raw data into information through: (A.B)  
(A) Statistics (B) Physics (C) Biometry (D) Bioeconomics
- When female mosquito pierces the skin of a man, it injects first of all: (K.B)  
(A) Saliva (B) Plasmodium (C) Antibodies (D) Both a and b

### ANSWER KEYS

### MULTIPLE CHOICE QUESTIONS

#### 2.1 BIOLOGICAL METHOD

1	D	11	B	21	B	31	A	41	B	51	C
2	B	12	B	22	B	32	B	42	B	52	B
3	B	13	D	23	B	33	C	43	D	53	C
4	B	14	A	24	B	34	A	44	C	54	B
5	C	15	C	25	B	35	B	45	C	55	C
6	C	16	D	26	B	36	A	46	B	56	A
7	D	17	A	27	A	37	B	47	B	57	B
8	C	18	C	28	B	38	C	48	C		
9	C	19	C	29	B	39	C	49	B		
10	B	20	A	30	B	40	C	50	C		

#### 2.2 DATA ORGANIZATION AND DATA ANALYSIS

1	A	2	B	3	C	4	B	5	C	6	A	7	A	8	A
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

**REVIEW QUESTIONS****MULTIPLE CHOICE QUESTIONS**

1. **Which one of the following is a correct sequence in biological method? (K.B)**
  - (a) Observations, Hypothesis, Law, Theory
  - (b) Hypothesis, Observations, Deduction, Experimentation
  - (c) Observations, Hypothesis, Deduction, Experimentation
  - (d) Law, Theory, Deduction, Observations
2. **Which one of these is NOT a characteristic of a hypothesis? (K.B)**
  - (a) Must be consistent with all available data
  - (b) Must be testable
  - (c) Must be correct
  - (d) Must make predictions
3. **At which point is a biologist most likely to use reasoning? (A.B)**
  - (a) While taking observations
  - (b) During hypothesis formulation
  - (c) During data organization
  - (d) None of the above
4. **A hypothesis must be testable to be scientifically valid. Being testable means that: (K.B)**
  - (a) Some observation could prove the hypothesis incorrect.
  - (b) Only a controlled experiment can indicate whether the hypothesis is correct or incorrect.
  - (c) The hypothesis is proven wrong
  - (d) The opposite of hypothesis is tested and proven wrong
5. **What would be the best experimental design for testing a hypothesis that bean plants require sodium? (K.B)**
  - (a) Measure the amount of sodium in a few bean plants
  - (b) Grow bean plants with and without sodium
  - (c) Look for sodium in leaf tissues
  - (d) Analyze root contents for sodium
6. **A gardener sees a large snake nearby. He knows that generally snakes sting, so the gardener ran away. The gardener did which of the following? (K.B)**
  - (a) Used reasoning
  - (b) Used observation
  - (c) Constructed a theory
  - (d) Tested a hypothesis
7. **A scientific theory has which of the following properties? (K.B)**
  - (a) It agrees with available evidence
  - (b) It cannot be rejected
  - (c) It has been absolutely proven
  - (d) It does not need to be altered in the light of new evidence
8. **Experimentation is only a step of scientific process, but it is a very important step because it always: (K.B)**
  - (a) Gives the biologist a correct result
  - (b) Allows rejection of some alternative hypotheses
  - (c) Ensures that hypotheses can be confirmed with certainty
  - (d) Gives scientists a chance to work in the laboratory

9. You are testing a hypothesis: 'Students learn more if they drink tea before sitting for study'. Your 20 experimental students drink tea before study; you test their learning by giving questions. Your 20 students of the control group should have all experimental conditions identical to the experimental group except that: (K.B)
- They should take tea with more milk and sugar
  - They should take tea before as well as during study
  - They should not take tea before study
  - After taking tea, they should not sit for study.

### ANSWER KEY

1	c	4	a	7	a
2	c	5	b	8	b
3	b	6	b	9	c

### UNDERSTANDING THE CONCEPTS

- i. Describe the steps involved in biological method taking malaria as an example. (K.B)  
 Ans: See the LQ.2 of (Topic 2.1)
- ii. If a test shows that some people have *Plasmodium* in their blood but they do not show any symptoms of malaria, what hypothesis would you formulate to answer this problem? (K.B)

Ans: FORMULATION OF HYPOTHESIS

The hypothesis can be formulated as:

- 'There is a specific time period between entry of *Plasmodium* in an individual's blood and appearance of malarial symptoms.'

*Plasmodium* is an infectious parasitic organism. Upon entry in an individual's body, it undergoes an 'Incubation period' of 7-10 days. Incubation period is the time period between entry of parasite in the host and the appearance of symptoms. During this period, *Plasmodium* multiplies in the stomach. When a sample of blood is checked for the presence of *Plasmodium* during this period, the patient is apparently healthy and no symptoms of disease, yet *Plasmodium* is detected in the blood.

- iii. How are the principles of ratio and proportion used in the biological method? (K.B)

Ans: See the LQ.2 of (Topic 2.2)

- iv. Justify mathematics as an integral part of the scientific process. (K.B)

Ans: See the LQ.3 of (Topic 2.2)

### SHORT QUESTIONS

1. Differentiate between theory and law. (K.B)

Ans: See the SQ.32 of (Topic 2.1)

2. Quantitative observations are better in biological method. How? (K.B)

Ans: See the SQ.7 of (Topic 2.1)

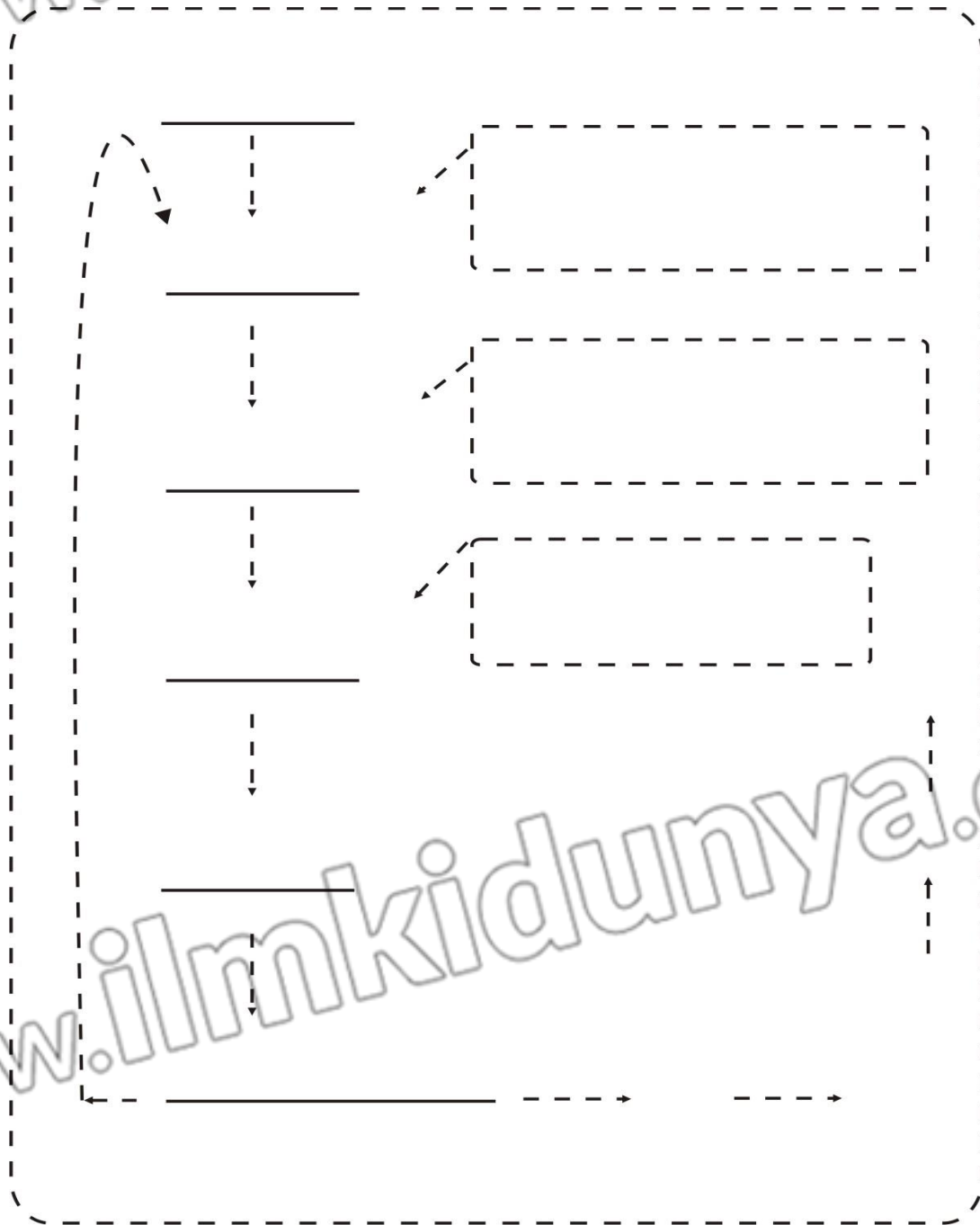
**KIPS ASSIGNMENT**

**LET'S DRAW AND LABEL**

Biological method

Instructions

- You can use lines instead of circles for each biological step.
- Write required information very carefully.





CUT HERE

**SELF TEST**

Time: 40 Min

Marks: 25

**Q.1** Four possible answers A, B, C and D to each question are given, mark the correct answer. (6×1=6)

1. Galileo performed his experiments in: (K.B)

- (A) 1690's (B) 1790's  
(C) 1590's (D) 1650's

2. "If I examine cells from a blade of grass, then each one will have a nucleus". This statement is: (U.B)

- (A) Theory (B) Hypothesis  
(C) Deduction (D) Law

3. Weight of one liter of ethanol: (K.B)

- (A) 689 grams (B) 789 grams  
(C) 879 grams (D) 1000 grams

4. Computational and statistical techniques for the analysis of biological data are studied in: (K.B)

- (A) Biomathematics (B) Biophysics  
(C) Bioinformatics (D) Biochemistry

5. A good observation requires 5 senses but an organism can sense the quality of eatable even lack of one sense: (K.B)

- (A) Hearing (B) Vision  
(C) Smell (D) Taste

6. Hypothesis "cigarette is a cause of lungs cancer". Which of the following experimental results proves this hypothesis? (A.B)

- (A) Some non-smokers have lungs cancer placed in control group  
(B) All non-smokers have healthy lungs placed in experimental group  
(C) Some smokers in experimental group have lungs cancer  
(D) All smokers have lungs cancer placed in experimental group

**Q.2** Give short answers to following questions. (5×2=10)

- (i) Define biological method. (K.B)  
(ii) What is the difference between qualitative and quantitative observations? (K.B)  
(iii) Develop a deduction from the following hypothesis. (U.B)  
"All plant cells have a nucleus."  
(iv) Describe the discovery of *Plasmodium*. (K.B)  
(v) What is difference between theory and law? (K.B)

**Q.3** Answer the following questions in detail. (5+4=9)

- (a) Describe the experiments of Ronald Ross for the investigation of malaria. (K.B) (5)  
(b) Write a note on data organization. (K.B) (4)

**Note:**

Parents or guardians can conduct this test in their supervision in order to check the skill of students.